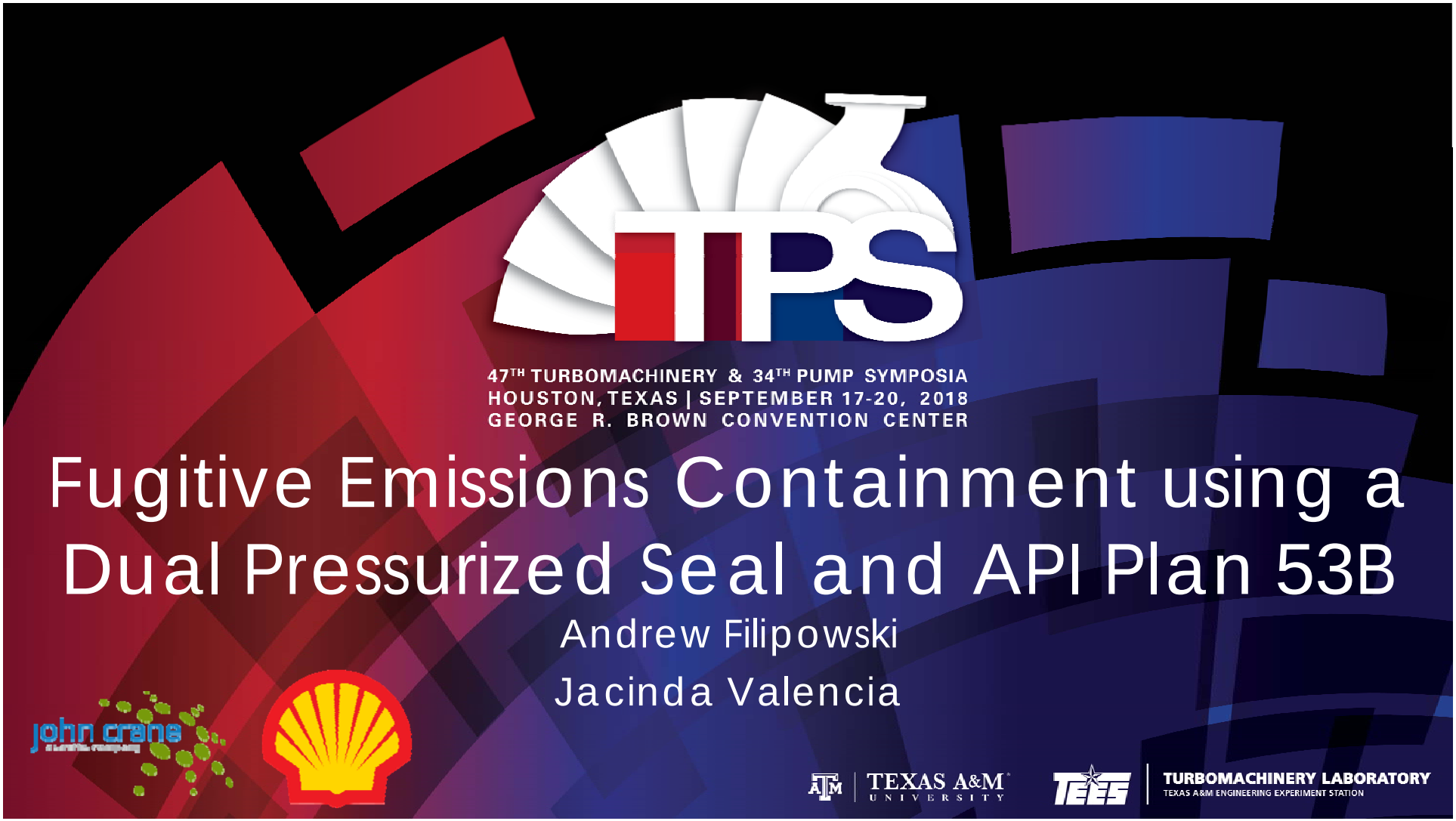
TPS
47TH TURBOMACHINERY & 34TH PUMP SYMPOSIA
HOUSTON, TEXAS | SEPTEMBER 17-20, 2018
GEORGE R. BROWN CONVENTION CENTER
Fugitive Emissions Containment using a Dual Pressurized Seal and API Plan 53B
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Presenter/Author bios

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Abstract

- Fluids that require limited emissions are often sealed using dual pressurized mechanical seals and sealing systems. API Plan 53B systems use a bladder accumulator to provide the pressure for the barrier fluid to isolate the process from the atmosphere. Reliable performance of these systems requires an understanding of the effects of temperature, barrier fluid volume, and seal chamber pressure to maintain a positive pressure differential. This case study will cover design considerations to improve performance, analysis of problems with an existing application, and the changes that were implemented to correct these problems.

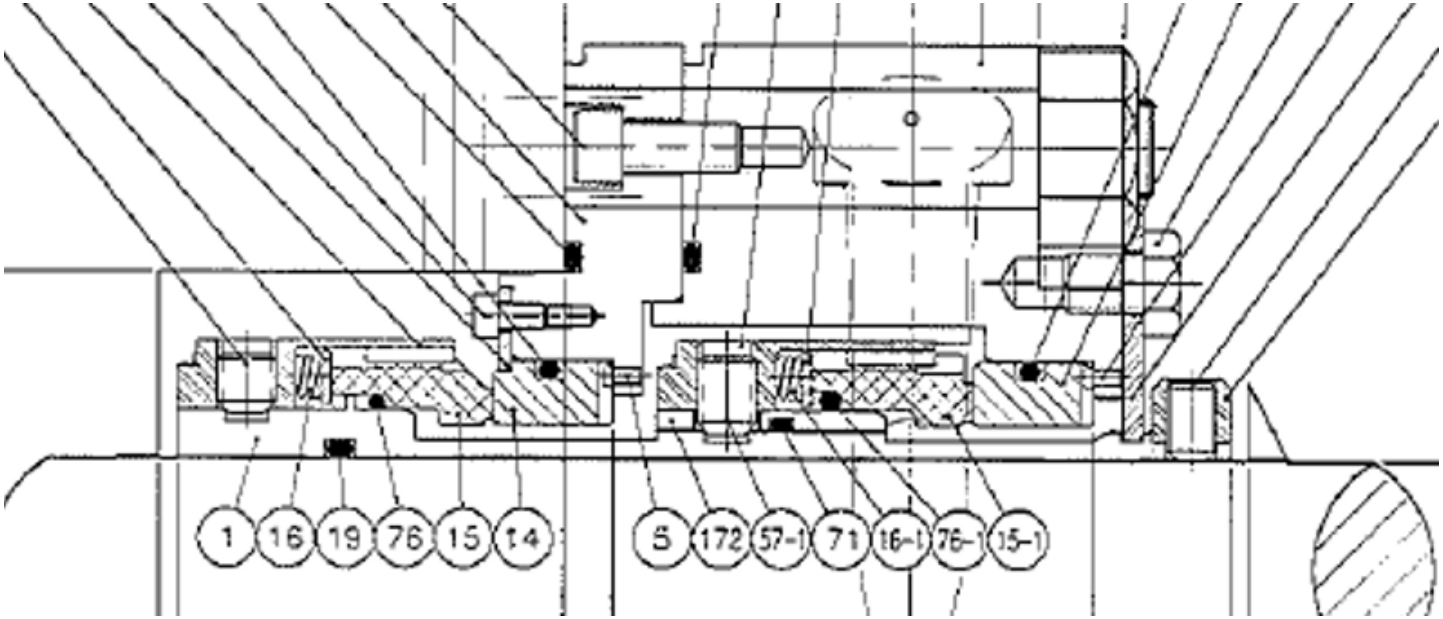
Application Summary

- Pump – API 610 OH2
- Speed – 3600 RPM
- Suction Pressure – 31.5 PSIG (217 kPa)
- Discharge Pressure – 256.5 PSIG (1768.5 kPa)
- Fluid – Benzene
- Temperature – 112 °F (44.4 °C)
- SG – 0.780

Application Summary Cont.

- Originally installed with a single pusher seal design
- Fugitive emissions requirements for the process required a dual pressurized seal
- Power end upgrade and dual pressurized seal installed in 2013
- API Plan 53B system installed for nitrogen pressure concerns

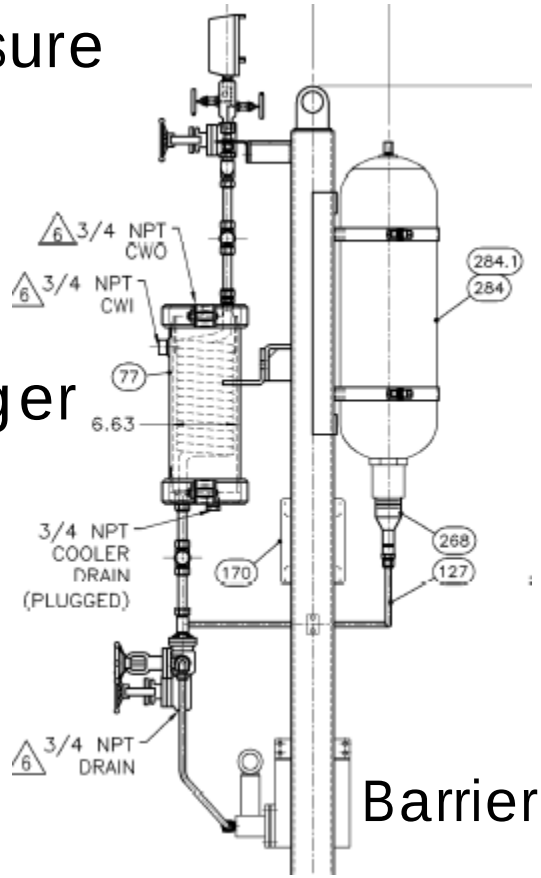
Dual Pressurized Mechanical Seal



Face to back arrangement with the barrier pressure on the ID of the inner seal

API Plan 53B Support System

Fixed Pressure Alarm



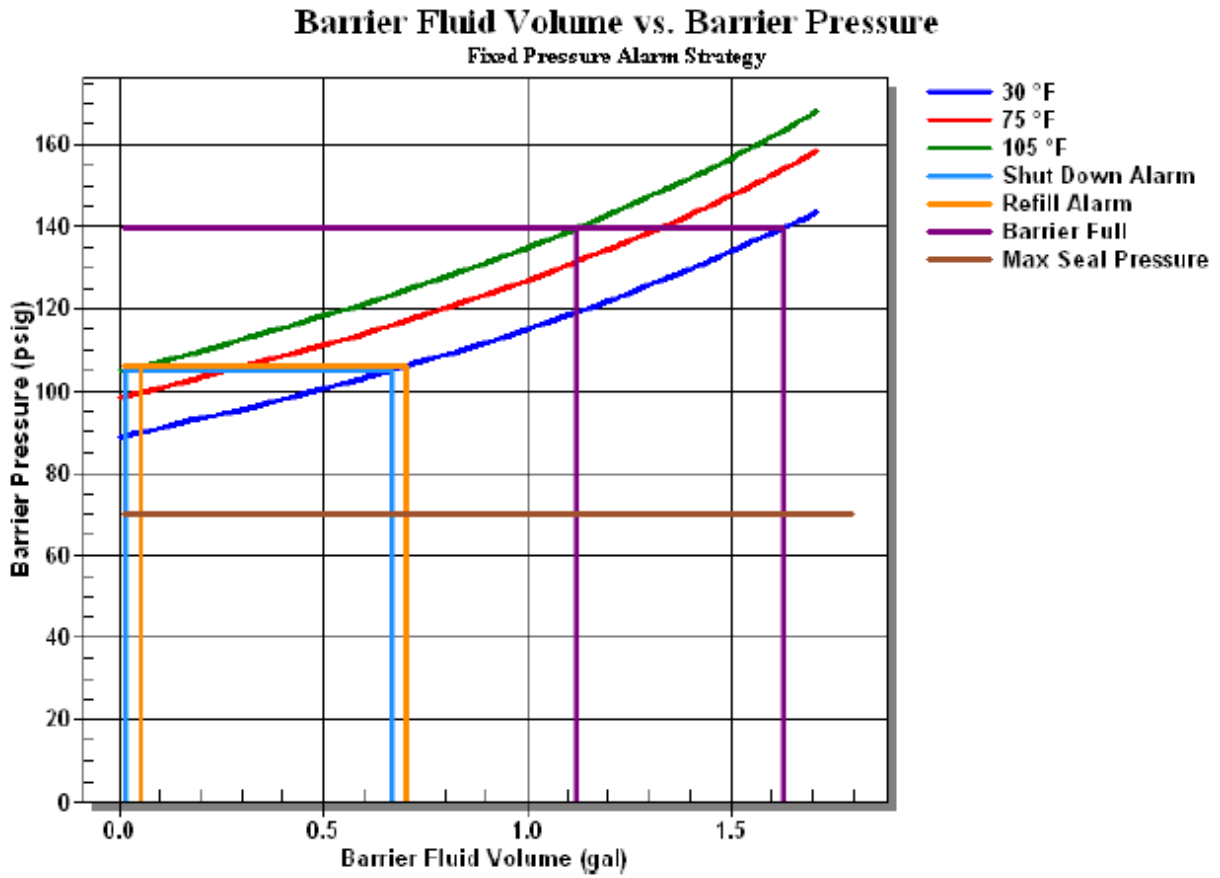
5 Gallon (19 L) Accumulator

Heat Exchanger

Barrier Refill Pump

Fixed Alarm Strategy

Effect of temperature and barrier fluid volume on bladder pressure



Initial Field Data

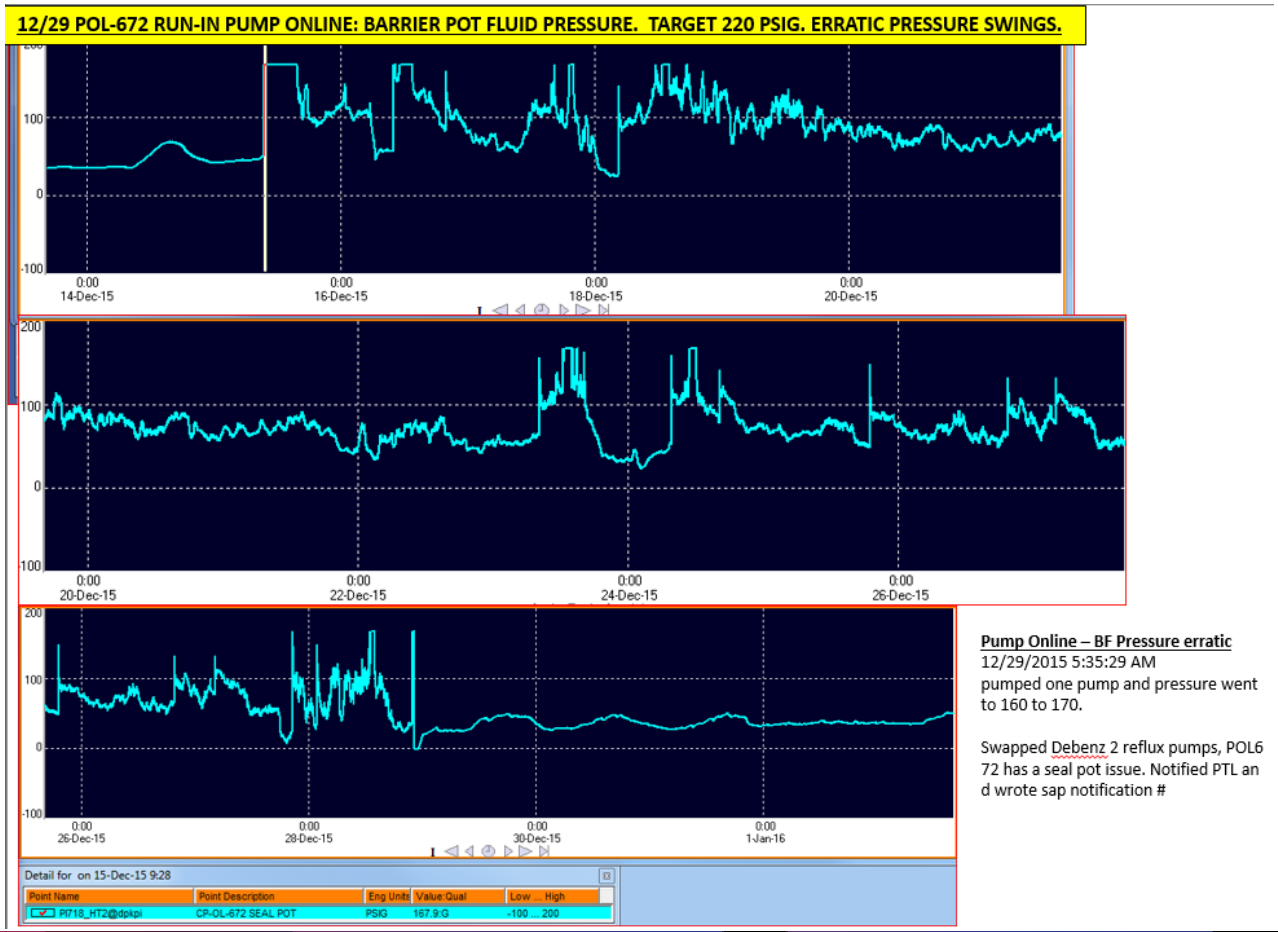
- Plan 53B Pressure –140 PSIG (965 kPa)
- Seal Chamber Pressure – 165 PSIG (1138 kPa)
- Barrier Fluid Refill Period – 12 hours
- MTBR – 6 months

Problems

- Wide swings in Plan 53B pressure
- High seal chamber pressure
- High barrier fluid temperatures
- Process fluid leaking into barrier fluid at times
- Barrier fluid leaking into pump and out to atmosphere
- Short barrier fluid refill periods
- Inner seal ID pressure differential limitations

Plan 53B Pressure Transmitter Trends for December 2015

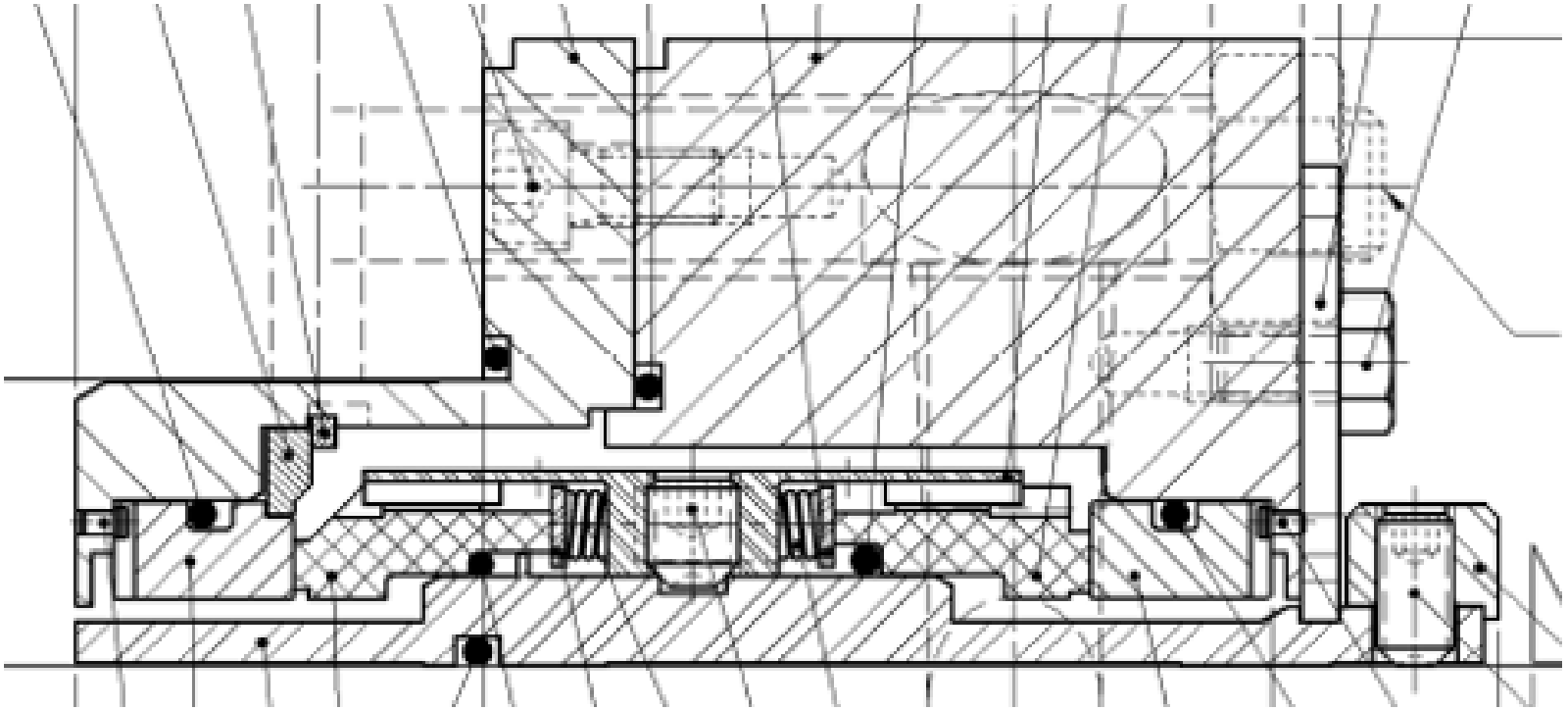
- Pressure swings from 50-180 psig (345-1240 kPa)
- Short refill periods



Attempted Fix

- Plan 53B set pressure was increased
- Orifice added to Plan 11
- Seal design changed from face to back arrangement to a back to back arrangement
- Plan 11 removed

Mechanical Seal Revision



Back to back arrangement with the barrier pressure on the OD of both seals

Field Data

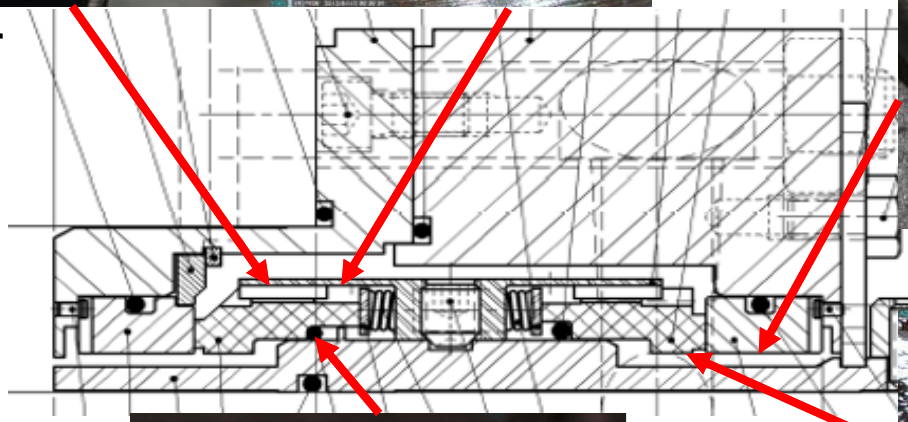
- Plan 53B Pressure – 220 PSIG (1517 kPa)
  - Dropped to 70 PSIG (483 kPa) in ~45 minutes after initial start
- Seal Chamber Pressure – 165-200 PSIG (1138-1379 kPa)
- Barrier Fluid Refill Period – 6-12 Hours

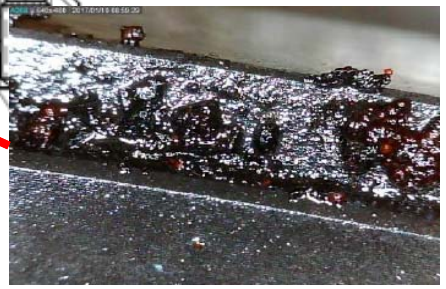
Problems

- High seal chamber pressure that increased over time
- High barrier fluid temperatures
- Process fluid leaking into barrier fluid
- Short barrier fluid refill periods
- Low pressure alarm set at 120 PSIG (827 kPa)
- Pressure transmitter range only up to 165 PSIG (1138 kPa)

Seal Findings

Drive Wear





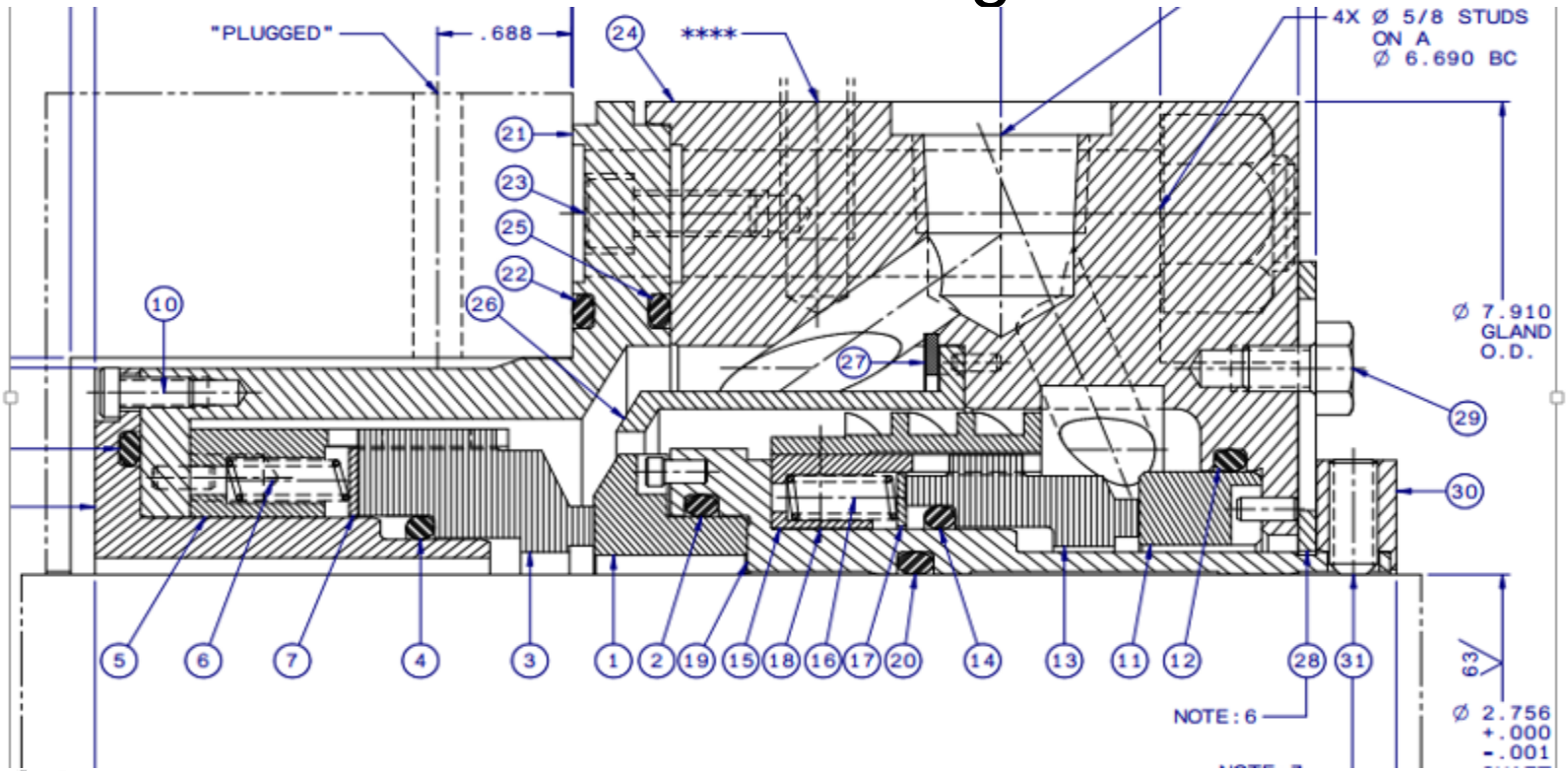
Barrier Fluid Deposits

Rolled O-ring

Analysis of Problems

- Low circulation of barrier fluid is increasing barrier fluid temperature and limiting lubrication
- Shuttling and hang up of the inner seal head
- Undersized balance holes increasing seal chamber pressure
- Undersized accumulator and fixed alarm strategy are limiting refill period

New Seal Design



Face to back arrangement with the barrier pressure on the OD of both seals

Seal Changes

Before

- Barrier pressure on the ID
- Barrier fluid circulated by radial flow features and thermosyphoning
- Stationary mating ring on inner seal
- Mating rings buried in seal gland

After

- Barrier Pressure on the OD
- Barrier fluid circulated by axial pumping ring with flow guide and thermosyphoning
- Rotating mating ring on inner seal
- Mating rings exposed to barrier fluid

Pump Changes

Before	After
• Balance Holes – 4 x 0.125”	• Balance Holes – 4 x 0.500”
• Eye Wear Ring OD – 4.803”	• Eye Wear Ring OD – 6.375”
• Case Wear Ring ID – 4.826”	• Case Wear Ring ID – 6.396”
• Hub Wear Ring OD – 6.482”	• Hub Wear Ring OD – 6.376”
• Cover Wear Ring ID – 6.505”	• Cover Wear Ring ID – 6.396”

Field Notes

After

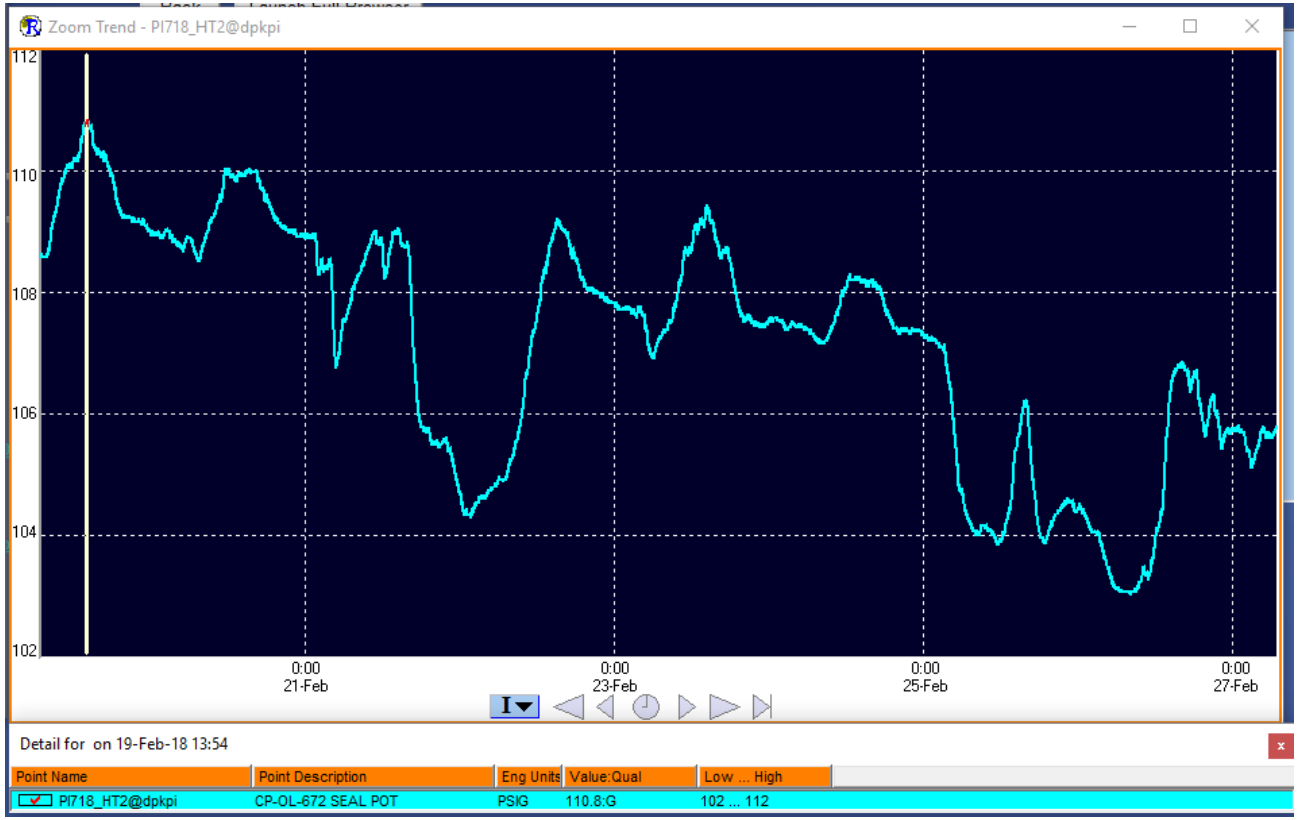
- Seal Chamber Pressure – 165-210 psig (1138-1448 kPa)
- Plan 53B Pressure – 140-220 psig (965-1517 kPa)
- Refill Period – 0-3 days

After

- Seal Chamber Pressure – 40 psig (276 kPa)
- Plan 53B Pressure – 115 psig (793 kPa)
- Refill Period – 15-21 days
- Barrier fluid 87 °F (31 ° C) into seal, 103 °F (39 °C) out of seal

Plan 53B Pressure Transmitter Trends for February 2017

- Barrier pressure ranging from 100-115 psig (690-793 kPa)
- Refill period 15-21 days

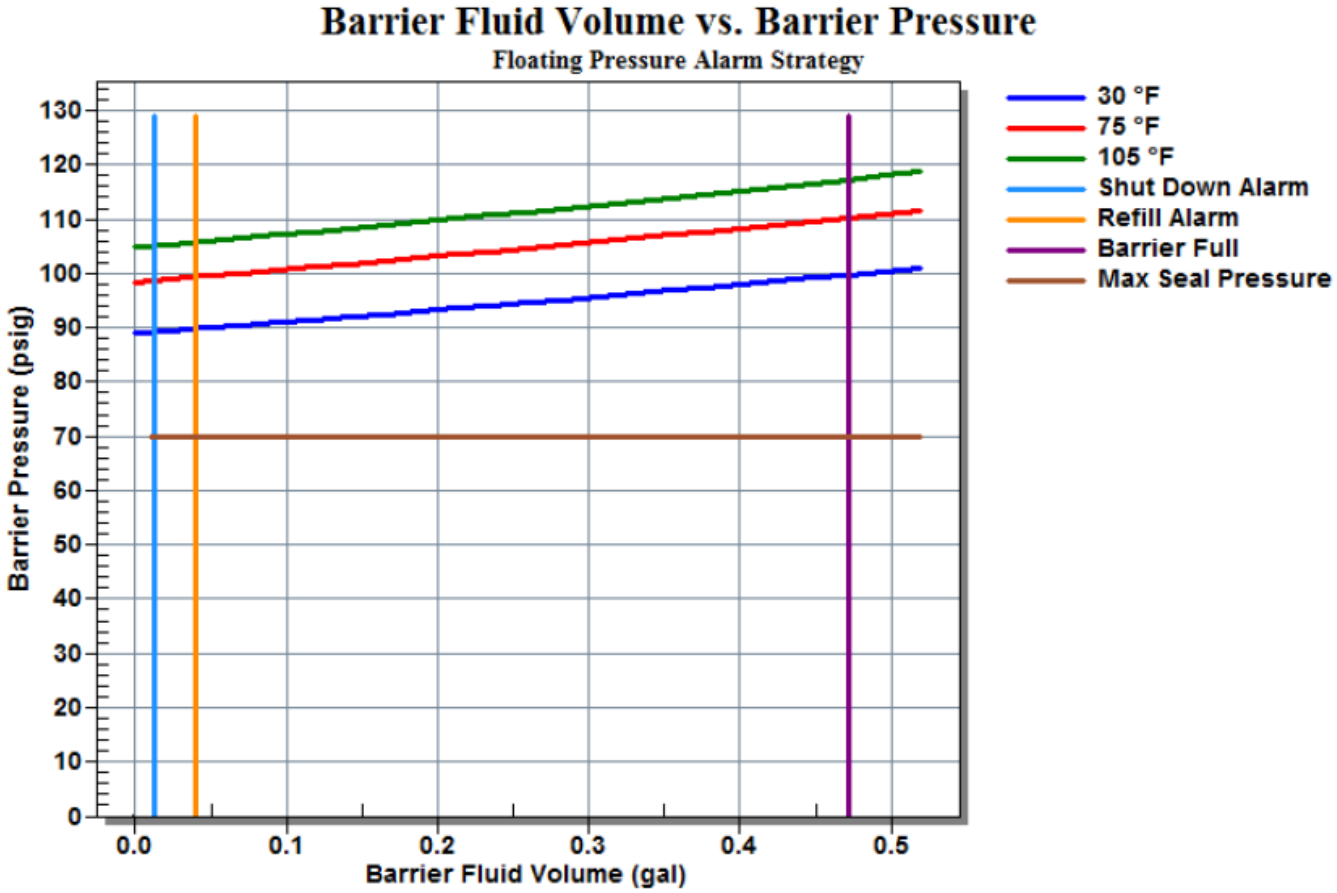


Outstanding Recommendations

- Increase size of accumulator from 5 to 9 gallons (19 to 34 L) or add second accumulator in series
- Lower barrier fluid set pressure
- Implement floating alarm

Floating Alarm Strategy

Floating alarm strategy alarms at the same barrier fluid volume regardless of temperature



Thank You

Any Questions?